

NOTES ON STONEHENGE.¹II.—ARCHÆOLOGICAL OBSERVATIONS AT STONEHENGE,
1901.

SOON after Mr. Penrose and myself had made our astronomical survey of Stonehenge in 1901, some archæological results of the highest importance were obtained by Prof. Gowland. The operations which secured them were designed and carried out in order to re-erect the leaning stone which threatened to fall, a piece of work recommended to Sir Edmund Antrobus by the Society of Antiquaries and other learned bodies, and conducted at his desire and expense.

They were necessarily on a large scale, for the great monolith, "the leaning stone," is the largest in England, Cleopatra's Needle excepted. It stood behind the altar stone, over which it leant at an angle of 65 degrees, resting at one point against a small stone of syenite. Half-way up it had a fracture one-third across it; the weight of stone above this frac-

The method employed by Prof. Gowland in the excavation should be a model for all future work of the kind. I have to express my thanks to the council of the Society of Antiquaries and Prof. Gowland for permission to use the accompanying illustrations showing the operations and results.

Above each space to be excavated was placed a frame of wood, bearing on its long sides the letters A to H, and on its short sides the letters R M L, each letter being on a line one foot distant from the next. By this means the area to be excavated was divided into squares, each having the dimension of a square foot. A long rod divided into 6-inch spaces, numbered from 1 to 16, was also provided for indicating the depth from the datum line of anything found. In this way a letter on the long sides of the frames, together with one on the short sides, and a number on the vertical rod, indicated the position of any object found in any part of the excavation.

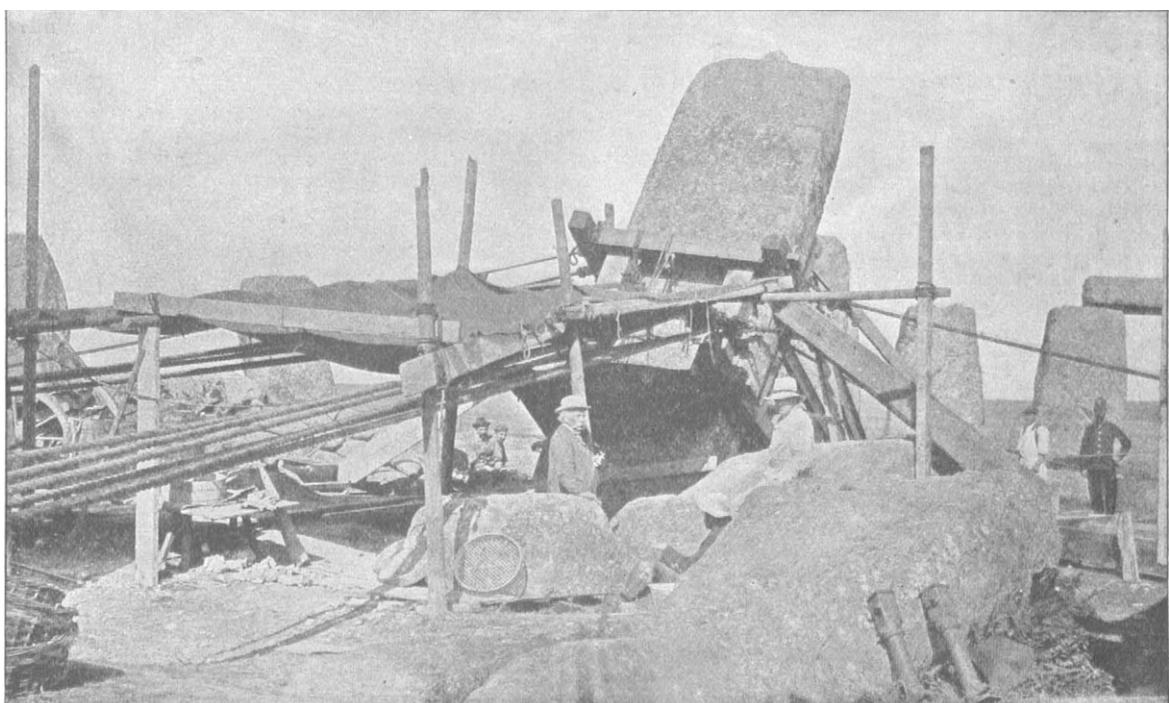


FIG. 4.—The arrangements for raising the stone.

ture was a dangerous strain on it, so that both powerful machinery and great care and precautions had to be used. Prof. Gowland was charged by the Society of Antiquaries with the conduct of the excavations necessary in the work. The engineering operations were planned by Mr. Carruthers, and Mr. Detmar Blow was responsible for the local superintendence. Mr. Blow thus describes the arrangements (*Journal Institute of British Architects*, 3rd series, ix., January, 1902):—

"A strong cradle of 12-inch square baulks of timber was bolted round the stone, with packing and felt, to prevent any marking of the stone. To the cradle were fixed two 1-inch steel eyebolts to receive the blocks for two six-folds of 6-inch ropes. These were secured and wound on to two strong winches fifty feet away, with four men at each winch. When the ropes were thoroughly tight, the first excavation was made as the stone was raised on its west side."

¹ Continued from p. 300.

Excavations were necessary because to secure the stone for the future the whole of the adjacent soil had to be removed down to the rock level, so that it could be replaced by concrete.

All results were registered by Prof. Gowland in relation to a datum line 337·4 feet above sea level. The material was removed in buckets, and carefully sifted through a series of sieves 1-inch, $\frac{1}{2}$ -inch, $\frac{1}{4}$ -inch, and $\frac{1}{8}$ -inch mesh, in order that the smallest object might not be overlooked.

From the exhaustive account of his work given by Prof. Gowland to the Society of Antiquaries (*Archæologia*, Iviii.), I gather three results of the highest importance from the point of view I am considering. These were, first, the finding of an enormous number of implements; secondly, the disposition and relative quantities of the chippings of the sarsen and blue stones; and thirdly, the discovery of the method by which the stones were originally erected.

I will take the implements first. This, in a con-

densed form, is what Prof. Gowland says about them :—

More than a hundred flint implements were found, and the greater number occurred in the stratum of chalk rubble which either directly overlaid or was on a level with the bed rock. They may all be arranged generally in the following classes :—

Class I.—Axes roughly chipped and of rude forms, but having well-defined, more or less sharp cutting edges.

Class II.—Hammerstones, with more or less well-chipped, sharp curved edges. Most may be correctly termed hammer-axes.

Class III.—Hammerstones, more or less rounded. Some specimens appear to have once had distinct working edges, but they are now much blunted and battered by use.

In addition to the above flint implements were found about thirty hammerstones, consisting of large pebbles or small boulders of the hard quartzite variety of sarsen. Some have been roughly broken into convenient forms for holding in the hand, whilst a few

ment. We evidently have to deal with builders doing their work in the Stone and not in the Bronze age. But was the age Palæolithic or Neolithic?

Prof. Gowland writes :—

"Perhaps the most striking features of the flint implements is their extreme rudeness, and that there is not a single ground or polished specimen among them. This, at first sight and without due consideration, might be taken to indicate an extremely remote age. But in this connection it must be borne in mind that in the building of such a stupendous structure as Stonehenge, the tools required must have been numbered by thousands. The work, too, was of the roughest character, and for such only rude tools were required. The highly finished and polished implements which we are accustomed to consider, and rightly so, as characteristic of Neolithic man, would find no place in such work. They required too much labour and time for their manufacture, and, when made, could not have been more effective than the hammer-axes and hammerstones found in the excavations, which could be so easily fashioned by merely

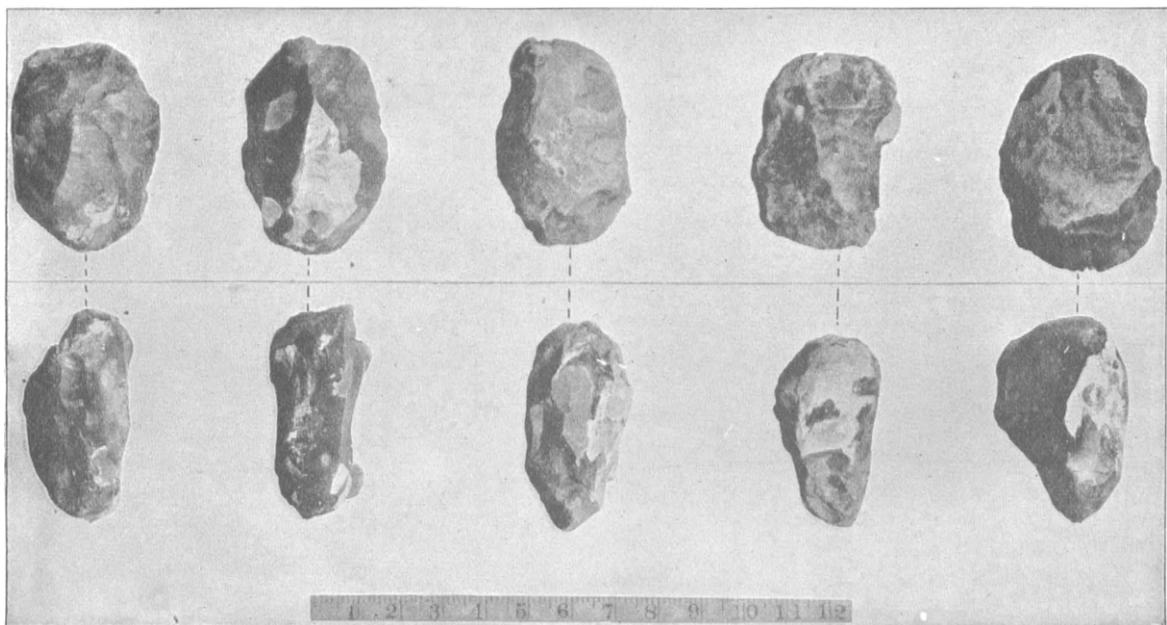


FIG. 5.—Some of the flint implements.

have been rudely trimmed into more regular shapes. They vary in weight from about a pound up to six and a half pounds. To these we have to add mauls, a more remarkable kind of hammerstone than those just enumerated. Their weights range from about 40 lb. to 64 lb.

How came these flints and stones where they were found? Prof. Gowland gives an answer which everybody will accept. The implements must be regarded as the discarded tools of the builders of Stonehenge, dumped down into the holes as they became unfit for use, and, in fact, used to pack the monoliths as they were erected. We read :—"Dealing with the cavity occupied by No. 55 before its fall, the mauls were found wedged in below the front of its base to act together with the large blocks of sarsen as supports (p. 54)." Nearly all bear evidence of extremely rough usage, their edges being jagged and broken, just as we should expect to find after such rough employ-

rudely shaping the natural flints, with which the district abounds, by a few well directed blows of a sarsen pebble."

On this ground Prof. Gowland is of opinion that, notwithstanding their rudeness, they may be legitimately ascribed to the Neolithic age, and, it may be, near its termination, that is, before the Bronze age, the commencement of which has been placed at 1400 B.C. by Sir John Evans for Britain, though he is inclined to think that estimate too low, and 2000 B.C. by Montelius for Italy.

Prof. Gowland guardedly writes :—

"In my opinion, the date when copper or bronze was first known in Britain is a very remote one, as no country in the world presented greater facilities for their discovery. The beginning of their application to practical uses should, I think, be placed at least as far back as 1800 B.C., and that date I am inclined to give, until further evidence is forthcoming, as the approximate date of the erection of Stonehenge."

Now the date arrived at by Mr. Penrose and myself on astronomical grounds was about 1700 B.C. It is not a little remarkable that independent astronomical and archaeological inquiries conducted in the same year should have come so nearly to the same conclusion. If a general agreement be arrived at regarding it, we have a firm basis for the study of other similar ancient monuments in this country.

I have previously in these "Notes" referred to the fact that the trilithons of the naos and of the outer circle are all built up of so-called "sarsen" stones. To describe their geological character, I cannot do better than quote, from Mr. Cunnington's "Geology of Stonehenge,"¹ their origin according to Prestwich:—

"Among the Lower Tertiaries (the Eocene of Sir Charles Lyell), are certain sands and mottled clays, named by Mr. Prestwich the Woolwich and Reading beds, from their being largely developed at these places, and from these he proves the sarsens to have been derived; although they are seldom found *in situ*,

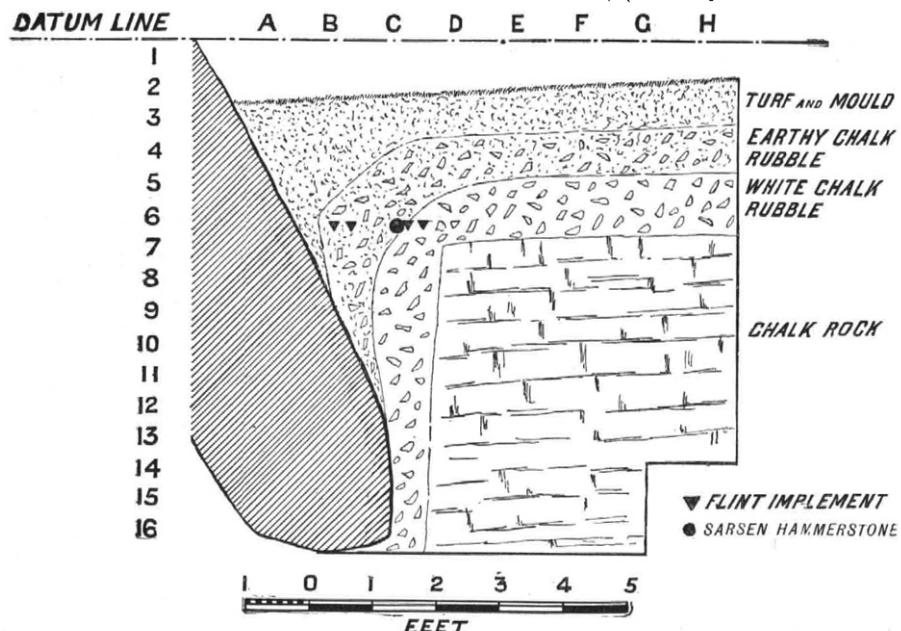


FIG. 6.—Face of rock against which a stone was made to rest.

owing to the destruction of the stratum to which they belonged.

The abundance of these remains, especially in some of the valleys of North Wilts, is very remarkable. Few persons who have not seen them can form an adequate idea of the extraordinary scene presented to the eye of the spectator, who, standing on the brow of one of the hills near Clatford, sees stretching for miles before him, countless numbers of these enormous stones, occupying the middle of the valley, and winding like a mighty stream towards the south."

These stones, then, may be regarded as closely associated with the local geology.

The exact nature of the stones, called "blue stones," can best be gathered from a valuable "Note" by Prof. Judd which accompanies Prof. Gowland's paper. These blue stones are entirely unconnected with the local geology; they must, therefore, represent boulders of the Glacial drift, or they must have

¹ Wiltshire Archaeological and Natural History Magazine, xxi. pp. 141-149.

been brought by man, from distant localities. Prof. Judd inclines to the first opinion.

The distinctions between these two kinds of stone are well shown by Prof. Gowland:—

"The large monoliths of the outer circle, and the trilithons of the horse-shoe are all sarsens—sandstones, consisting of quartz-sand, either fine or coarse, occasionally mixed with pebbles and angular bits of flint, all more or less firmly cemented together with silica. They range in structure from a granular rock resembling loaf sugar in internal appearance to one of great compactness similar to quartzite."

"The monoliths and trilithons all consist of the granular rock. The examples of the compact quartzite variety were, almost without exception, either hammerstones that had been used in shaping and dressing the monoliths, or fragments which had been broken from off them."

"The small monoliths, the so-called 'blue stones,' which form the inner circle and the inner horse-shoe, are, with the undermentioned exceptions, all of diabase more or less porphyritic. Two are porphyrite (formerly known as felstone or hornstone). Two are argillaceous sandstone."

"Mr. William Cunningham, in his valuable paper, 'Stonehenge Notes,' records the discovery of two stumps of 'blue stones' now covered by the turf. One of these lies in the inner horseshoe between Nos. 61 and 62, and 9 feet distant from the latter. It is diabase. The other is in the inner circle between Nos. 32 and 33, 10 feet from the former, and consists of a soft calcareous altered tuff, afterwards designated for the sake of brevity fissile rock.

The altar stone is of micaceous sandstone."

I now come to the second point, to which I shall return in subsequent "Notes."

In studying the material obtained from the excavations, it was found in almost every

case that the number of chippings and fragments of blue stone largely exceeded that of the sarsens; more than this, diabase (blue stone) and sarsen were found together in the layer overlying the solid chalk (p. 15). Chippings of diabase were the most abundant, but there were few large pieces of it. Sarsen, on the other hand, occurred most abundantly in lumps (p. 20); very few small chips of sarsen were found (p. 42). Hence Prof. Gowland is of opinion that the sarsen blocks were roughly hewn where they were found (p. 40); the local tooling, executed with the small quartzite hammers and mauls, would produce dust.

Finally, I reach the third point of importance from the present standpoint; the excavations produced clear evidence touching the mode of erection. Prof. Gowland's memoir deals only with the leaning stone, but I take it for granted that the same method was employed throughout. This method was this:—

(1) The ground on the site it was to occupy was removed, the chalk rock being cut into in such a

manner as to leave a ledge, on which the base of the stone was to rest, *and a perpendicular face rising from it, against which as a buttress one side would bear when set up.* From the bottom of this hole an inclined plane was cut to the surface, down which the monolith which had already been dressed was slid until its base rested on the ledge.

(2) It was then gradually raised into a vertical position by means first of levers and afterwards of a ropes. The levers would be long trunks of trees, to one end of which a number of ropes were attached (this method is still employed in Japan), so that the weights and pulling force of many men might be exerted on them. The stronger ropes were probably of hide or hair, but others of straw, or of withes of hazel or willow, may have been in use for minor purposes.

(3) As the stone was raised, it was packed up with logs of timber and probably also with blocks of stone placed beneath it.

(4) After its upper end had reached a certain eleva-

GEOLOGY OF THE MOON.

FOR many years past geologists have turned wistfully to the moon in the hope of gaining from a study of its surface some insight into planetary evolution, and more especially into some of the stages in the history of our own globe. It must be confessed, however, that as yet few satisfactory data have been obtained, either in the facts observed or in the deductions drawn from them. The great majority of those who have studied the subject have formed the opinion that our satellite was once a liquid mass, such as we believe the earth itself to have also been, and that its so-called "craters" represent extensive and prolonged volcanic activity, when the gases and lava of the heated interior escaped to the surface, probably on a scale of magnitude greatly surpassing that on which subterranean energy has ever been manifested in the geological history of our planet. But another explanation has been proposed for these lunar features, according to which, as worked out by Mr. G. K.



FIG. 7.—The present aspect of the monument with the leaning stone raised.

tion, ropes were attached to it, and it was then hauled by numerous men into a vertical position, *so that its back rested against the perpendicular face of the chalk which had been prepared for it.* During this part of the operation, struts of timber would probably be placed against its sides to guard against slip.

As regards the raising of the lintels, and imposts, and the placing of them on the tops of the uprights, there would be even less difficulty than in the erection of the uprights themselves.

It could be easily effected by the simple method practised in Japan for placing heavy blocks of stone in position. The stone, when lying on the ground, would be raised a little at one end by means of long wooden levers. A packing of logs would then be placed under the end so raised, the other extremity of the stone would be similarly raised and packed, and the raising and packing at alternate ends would be continued until the block had gradually reached the height of the uprights. It would then be simply pushed forward by levers until it rested upon them.

I shall deal later on with several interesting conclusions to which these investigations lead.

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Gilbert, of the United States Geological Survey, the moon was formed by the aggregation of a ring of meteorites which once encircled the earth, and the "craters," instead of arising from the escape of volcanic energy from within, were produced by the impact of the last meteoric bodies that fell from without. These bodies, arriving with planetary velocity, would be melted or reduced to gas, while a portion of the lunar surface around them would also be liquefied. Mr. Gilbert believes that the lunar topography bears witness to such a meteoritic bombardment rather than to gigantic volcanic explosions.

The latest contribution to the discussion was recently presented to the Academy of Sciences of Paris by MM. Loewy and Puiseux. These eminent astronomers direct attention to the evidence furnished by the latest photographic charts of the "Atlas Lunaire" in regard to the conditions in which a planetary body passes from the liquid to the solid state, and to the stage in this transformation which has been reached respectively by the earth and the moon.

With respect to the evolution of the earth two opposite theories have been propounded. The great body of geologists have maintained that the interior